Space Weather Technical Forecast

Issued on Wednesday, 03 May 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1 Minor-R2 Moderate radio blackouts expected throughout. Chance of R3 Strong radio blackouts. Slight chance of G1/Minor Storm conditions to start and end of period. Active electron fluence continuing.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate through the last 24 hours, due to a series of M-class flares, peaking at M7.4 at 03/1045UTC from AR3293, which contains a complex delta spot and is rapidly evolving. AR3296, to the east of this region is also evolving quickly, but is still too close to the northeast limb to carry out a full analysis. AR3288, close to the southwest limb, also contains a delta spot and flared around the same time as AR3293, perhaps contributing some of the energy to the observed X-ray flux attributed to this region. AR3297 is also complex but relatively inactive. There are eight regions on the disc in total, with the remaining four regions relatively simple and inactive.

Two CMEs which emerged from the northwest of the solar disc late on 02 May have been analysed and confirmed as far-sided eruptions, with no forecast Earth-directed component.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1 has slowly declined from close to 500km/s, to 480km/s as the probable high speed stream from coronal hole 98 wanes. Density has been around average. Total magnetic field strength was weak, below 5nT, with the north-south component, Bz, also varying weakly. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has been at mostly High levels, peaking at 5380 pfu at 02/1730 UTC. The 24-hour integrated fluence was at Active levels, with a decreasing trend, 2.42e8 integrated pfu recorded at 03/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Moderate activity is expected through the next four days as two magnetically complex regions in the northeast quadrant, with a history of notable activity rotate across the solar disc. There is a chance of X-class flares, mainly from these region.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 29 Apr may glance the Earth on 03 May, but with a declining risk through the day. Further analysed CMEs are determined not to be Earth-directed. The current high speed stream, likely to be from coronal hole 98 is expected to decline through 03 and 04 May, with a further high speed stream, from coronal hole 99 perhaps connecting on 05 May. As this is not a recurrent feature, the strength of any connection is uncertain. Geomagnetic activity is expected to be mainly Quiet, with a slight chance of Active or G1/Minor Storm intervals on 03 and 05 May.

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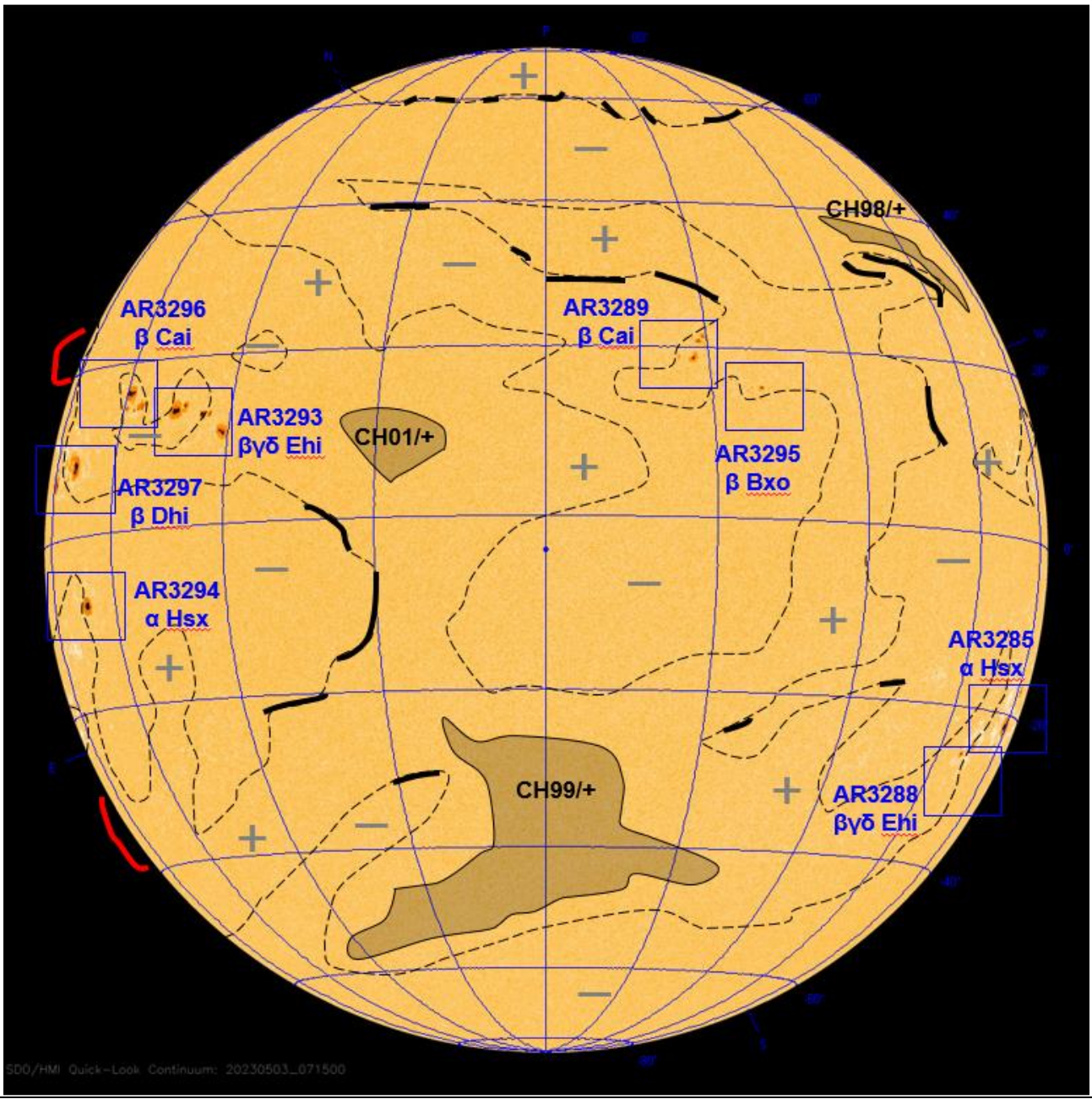
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to persist at background levels. However count rates may increase with any significant flares that occur, with a slight chance of reaching the S1 Minor radiation storm threshold throughout, with an increasing risk of AR3293 rotates towards the northwest quadrant. High energy (greater than 2MeV) electron flux is expected to continue a diurnal oscillation, mainly above the high threshold, but with slightly declining peaks. Brief sharp declines are possible from low probability geomagnetic activity. Electron fluence is expected to continue mainly above the threshold, with slightly decreasing confidence later in the period, due to possible brief increases in geomagnetic activity.

Figure 1. Solar Analysis Valid 03/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A number of faint filaments have erupted from the Sun through the last few days, with the majority of these assessed as not being Earth-directed. However, given the margin of error, especially through assessment of ensemble forecasts, there is a risk of some weak glancing blows during the next four days. A CME which left the Sun on 29 Apr from the vicinity of AR3288 may glance the Earth, with a declining risk during 03 May. A large asymmetric full halo which left the Sun on 02/0400UTC was assessed as a far-sided eruption and is not forecast to affect the Earth. Two further eruptions from the northwest and southwest late on 02 May have also been assessed as farsided eruptions.

The current high speed stream, likely from weak coronal hole 98 in the northwest, continues to erratically decline. Analysis of STEREO A data, which is now less than one day ahead of the Earth, suggests that solar wind speeds could decline to around 400km/s through the next 36 hours, ahead of a further high speed stream connection on 05 May from coronal hole 99. This feature, in the south of the southern hemisphere is in the same hemisphere relative to Earth, but is a non-recurrent feature and has not yet been observed on satellite imagery, therefore a speed of 500km/s is assumed.

Geomagnetic activity is expected to be mainly Quiet, with isolated risks of active intervals on 03 and 05 May due to any glancing CME arrivals and coronal hole connections respectively.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	5	10	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares:
There are eight sunspot regions on the visible disc, with the most prominent and active of these AR3293. This region is becoming increasingly complex, with a strengthening delta spot in the centre, where a positive region is sandwiched between two negative regions within the same penumbra. This suggests potential convective emergence from below the photosphere and increasing magnetic complexity. Magnetic field lines are also becoming contorted, with a risk of significant flare activity. This has already been partially realised through an M7.4 flare, which was the highest of three M-class flares from this region as it develops. This now presents an increased risk of X-class flaring which is reflected in the flare probabilities.

The region just to the east of AR3293, AR3296, is also developing rapidly and could reveal further complexity as it moves onto the disc. In addition AR3288, which also contains a delta spot is moving towards the southwest limb, but has also produced two large flares in the last 12 hours, and will have contributed some energy to the total X-ray flux which has been attributed to AR3293. AR3297 on the limb close to the eastern equator is a Beta region, and despite low levels of activity appears relatively complex. The remaining regions are all relatively simple.

As mentioned the flare probabilities have been elevated in light of the developments around AR3293 and AR3296. AR3288 is expected to rotate from view through the next 36 hours, but could still present a flare risk from beyond the limb. M-class flares are expected through the next four days based on current trends of development, with a chance of X-class flares, mainly from the northeast quadrant.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			**(%)**	**(%)**	**(%)**	**(%)**
Active	**R1-R2 M Class**	Yes	90	80	80	80
Very Active	**R3 to R5 X Class**	No	20	20	20	20

Figure 2: 24 hour X-ray flux

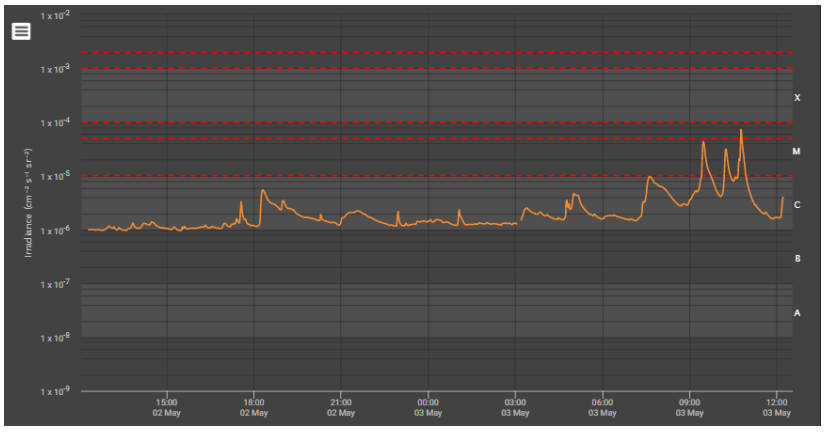

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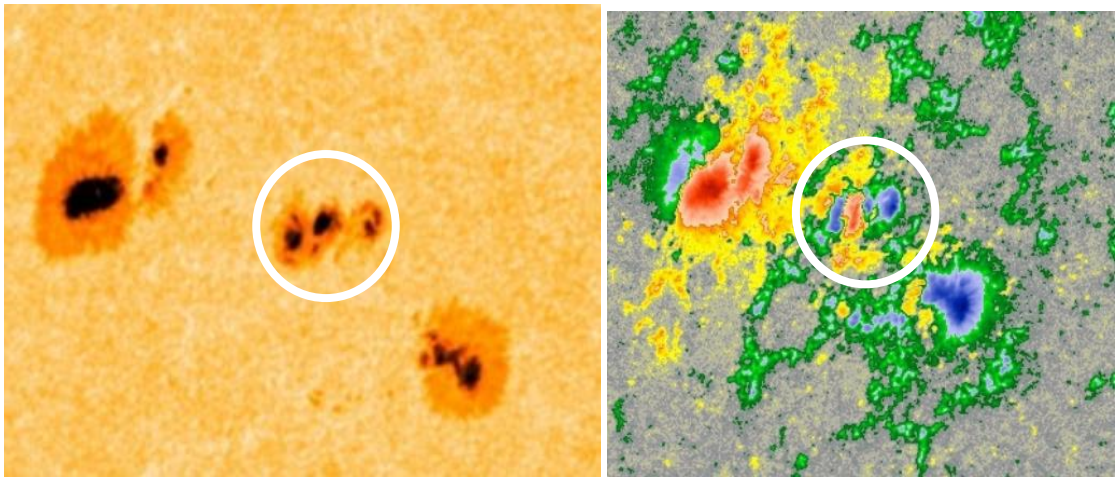
Figure 3: AR3293 in the northeast quadrant, with the delta region circled.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is forecast to remain at background, with no solar radiation storms expected.

AR3293 present the most significant risk of proton storms due to increasing magnetic complexity and concurrent increases in solar activity. As this region is in the northeast, any radiation storms are unlikely to significantly affect Earth through much of the period, with a chance on 06 May as the region rotates into the northwest quadrant.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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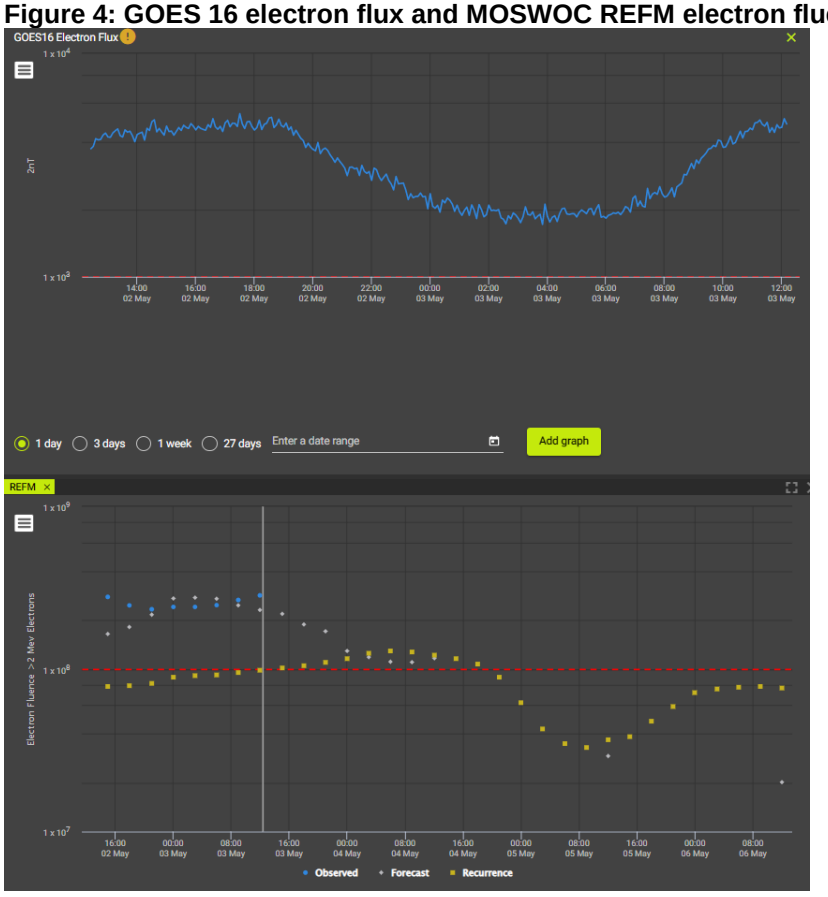
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) at GEO is expected to continue to follow an oscillating diurnal cycle above the high (1e3pfu threshold through the next four days, in the absence of any significant modifying factors. The value of the peaks may fall slowly, but with these peaks still likely to exceed the high threshold. Modifying factors such as a low probability CME glance on 03 May and a possible high speed stream connection on 05 May could briefly suppress electron counts.

Electron fluence values are at Active (1e8 integrated pfu) levels and are expected to continue above this threshold for much of the period. A steady decline could occur, but this is likely to be a very steady decline.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	80	60	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES 16 electron flux and MOSWOC REFM electron fluence



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